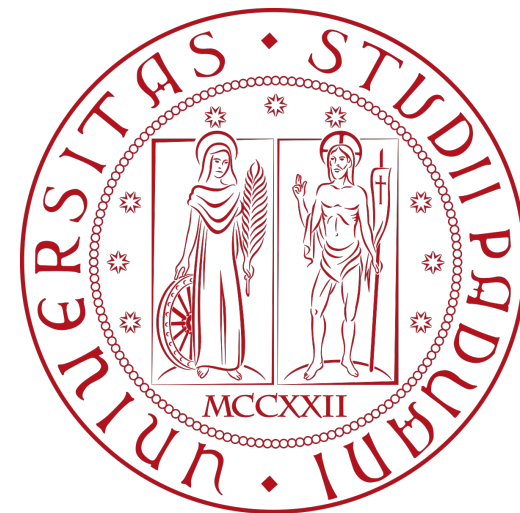




DIPARTIMENTO
MATEMATICA

DIPARTIMENTO DI MATEMATICA "TULLIO LEVI-CIVITA"



KNOWLEDGE AND DATA MINING

«Number Mind»

Problem

The game ***Number Mind*** is a variant of the well known game *Master Mind*. Instead of colored pegs, a secret sequence of n digits has to be guessed. After each proposed solution it is only told in how many places the correct digit was guessed.

For instance, given the following guesses for the 5-digit unique secret sequence *39542* :

90342 ; 2 correct
70794 ; 0 correct
39458 ; 2 correct
34109 ; 1 correct
51545 ; 2 correct
12531 ; 1 correct

Domain Clauses

Language

For $d = 0, 1, \dots, 9$ and $p = 0, 1, \dots, n-1$ define the proposition $\text{Index}(p, d)$ that means that is TRUE that the digit d is in position p of the sequence of length n .

Domain Axioms

Exactly one digit in each position:

at least one
digit in each
position



at most one
digit in each
position

Domain Clauses

At least one digit in each position. For every position $p = 0, 1, \dots, n-1$:

$$\bigwedge_{\substack{I \subseteq \{0, 1, \dots, m-1\} \\ |I| = m-k+1}} \bigvee_{i \in I} \textit{Index}(p, i)$$

with the number of different digits $m=10$ and $k=1$.

$$\implies \bigvee_{i \in \{0, 1, \dots, 9\}} \textit{Index}(p, i)$$

Domain Clauses

At most one digit in each position. For every position $p = 0, 1, \dots, n-1$:

$$\bigwedge_{\substack{I \subseteq \{0, 1, \dots, m-1\} \\ |I| = k+1}} \bigvee_{i \in I} \neg \text{Index}(p, i)$$

with the number of different digits $m=10$ and $k=1$.

$$\implies \bigwedge_{\substack{I \subseteq \{0, 1, \dots, 9\} \\ |I| = 2}} \bigvee_{i \in I} \neg \text{Index}(p, i)$$

Problem Clauses

At every iteration a sequence has to be guessed, considering the feedback on the correct digits of **all** the previous proposed solutions.

At every iteration, knowing that exactly k digits of the guessed sequence are in the correct position, all the possible combinations of **exactly** k correct digits of the guessed sequence (tuples with *position* and *digit*) are formalized as axioms.

Problem Clauses

At every iteration, given that S is the set of each possible subsequence of the currently guessed sequence written as tuples (position, digit), the following axioms are added :

- At least k correct digits in the correct position

$$\bigwedge_{\substack{s \subseteq S \\ |s|=n-k+1}} \bigvee_{(p_s, d_s) \in s} \textit{Index}(p_s, d_s)$$

- At most k correct digits in the correct position

$$\bigwedge_{\substack{s \subseteq S \\ |s|=k+1}} \bigvee_{(p_s, d_s) \in s} \neg \textit{Index}(p_s, d_s)$$